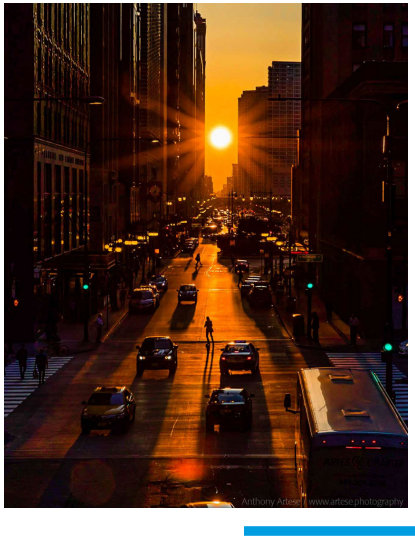
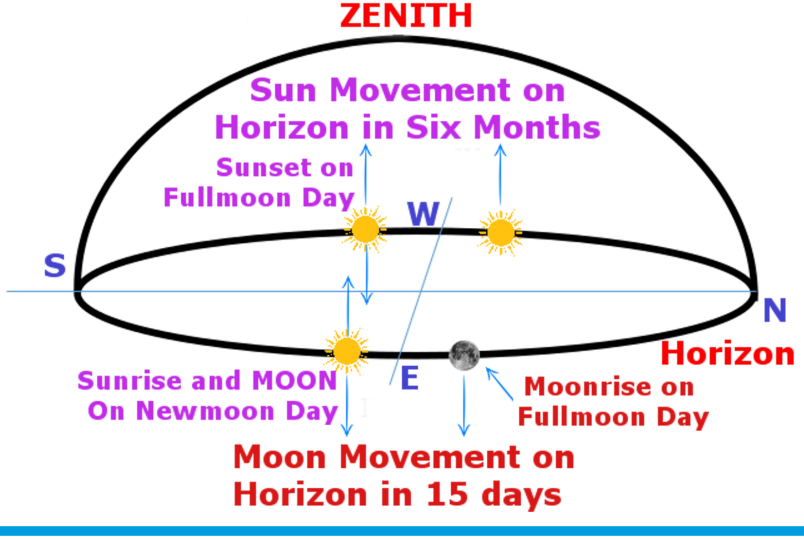
Sun-moon-stars



Sunrise can be through the central arch of the four thousand year old StoneHenge in England, only on the day sunrise begins to move south, called the summer solstice. {Picture left above} Similarly, many temples in India have been so constructed that the rays of the sun fall on the idol inside on special days {Picture right above}. It is actually quite easy to do this. As mentioned earlier, the sun is at a specific place in the sky only once or rarely twice a year. If a narrow doorway is positioned to match the sun position on a specific day and time, the sun will return to that position after every year and the sun's rays will fall on the idol placed opposite the doorway. This road in Chicago city {Picture left} is aligned along true east-west and so every year, the setting sun appears between the tall buildings on equinox days.

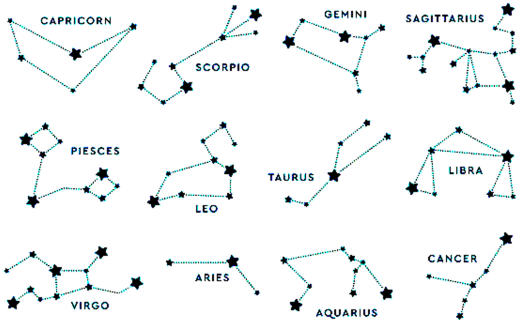
In the picture on page 9, the sunrise position changes by an angle of about 60° during the course of a year. The moon also moves on the horizon but over a month rather than a year. The moon is visible only when sunlight is reflected towards the earth. On full moon day the sun and moon are opposite one another and the full face of the moon is visible. On new moon day they are side by side and so the moon is not seen. Sunlight does not fall on the face of the moon facing the earth. In between, only part of the moon surface illuminated by the sun is visible from the earth. This is what we call the crescent moon. As shown in the picture below, at a place north of the equator, sunset is south of true east and it is a full moon day. For the full face of the moon to be illuminated, the rising moon should be opposite the sun, that is north of true east. Fifteen days later the position of sunset would



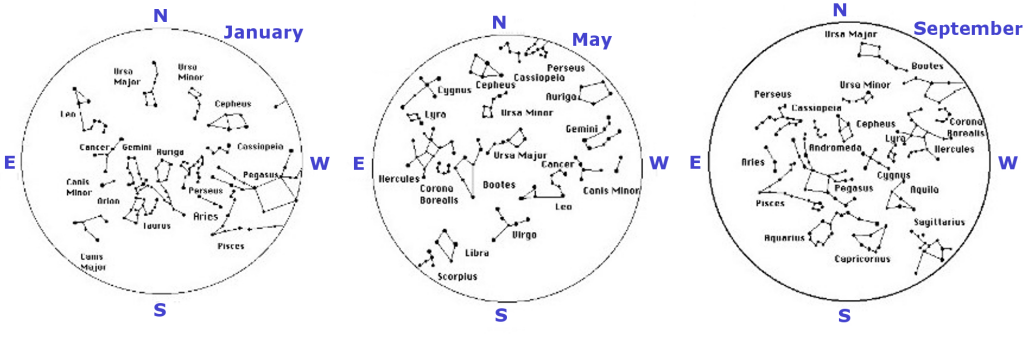
not change much. But the moon has to be next to the sun on new moon day. So the moon should also be south of the true west. The angle on the horizon travelled by the sun in six months is covered by the moon in 15 days. {Picture previous page} If the sunset is at true west on an equinox day, the rising full moon has to be at true east, opposite the setting sun. Fifteen days later the sunset is still almost at true west and the moon is also at the same place on new moon day. The moon has not moved much on the horizon. So the actual movement of the moon on the horizon depends on whether the sun is at equinoxes or the solstices. It depends not only on the place of observation as in the case of the sun but also on the position of the sun.

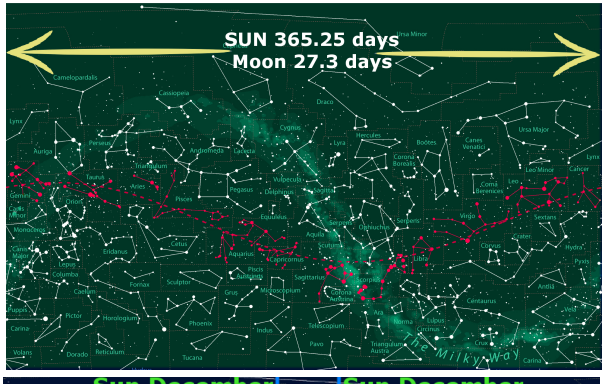
On every new moon day, the moon is near the sun in the sky but sometimes it comes exactly between the sun and the earth. We then observe a solar eclipse. At present, from the earth, the sun and the moon appear to be of the same size. When the moon covers the sun completely, the solar eclipse is total. There is complete darkness. A few stars and a large corona around the sun becomes visible. {pictures below left} Total solar eclipses are extremely rare. They can only be seen from a small area of the earth and for a few minutes at any one time. Most solar eclipses are partial. Picture on left shows a full lunar eclipse. This occurs on a full

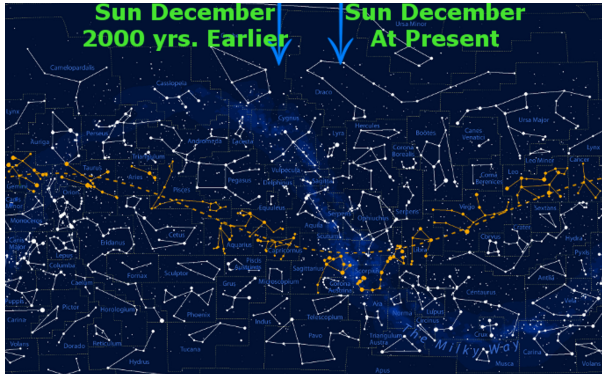
moon day when the earth is exactly in between the sun and the moon. The crescent shape shows the moon in its normal colour. The rest of the moon shows the red colour only seen during an eclipse due to the earth's atmosphere.



The stars appear to rotate around the Polaris but one star does not move closer to or farther from another. So ancient humans imagined pictures in a group of stars and called them constellations. The 12 constellations of the zodiac, Cancer, Leo Virgo etc. are the most familiar ones. {Picture left} Stars are not visible after sunrise, except briefly during a total solar eclipse. But, if one looks carefully, {Picture below} the stars right overhead at midnight change from month to month. So, the sun must be moving with respect to the stars

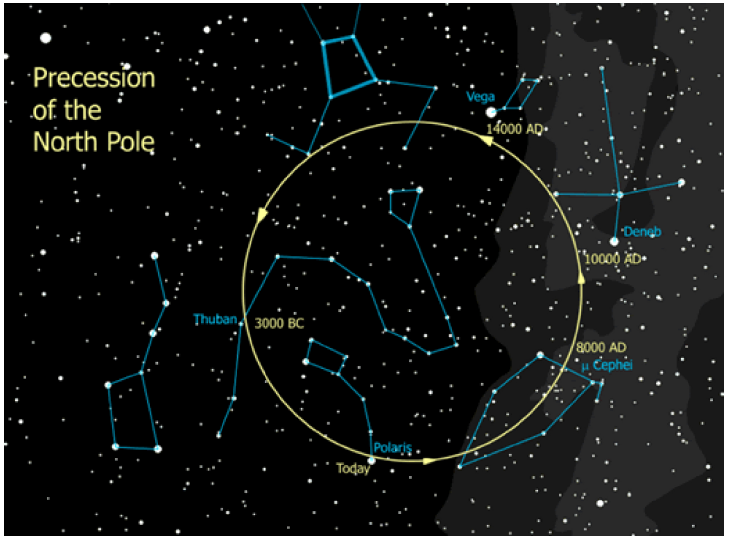


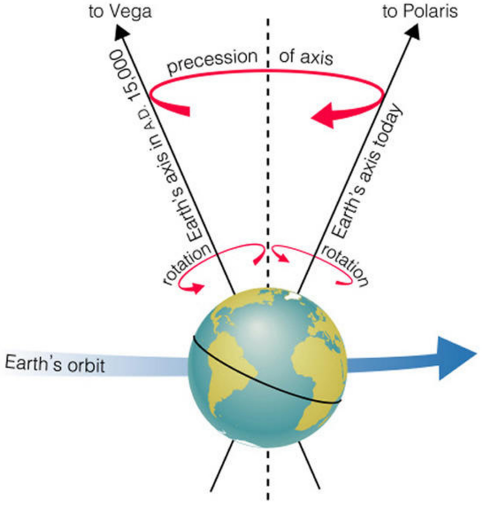




from one month to the next. As the night progresses, it easily becomes clear that the moon is moving closer to one star and farther from another. The moon returns to the same star after about 27-28 days. So the moon takes a month to cross the visible stars in its path and return to the starting point. The sun takes one year for this {Picture left above}.

Actually the stars are not revolving around the Polaris. The earth is spinning on its axis creating the illusion that the stars are rotating around the Polaris. Similarly, the sun is not moving through the constellations of the zodiac. The earth going round the sun causes the illusion. At present, when the sunrise begins to move north, the sun is in the constellation Sagittarius. About two thousand years ago, when the sunrise began to move north, sun was in the constellation Capricorn. {Picture left bottom}. Observing this, the Indians began to associate the northward movement with the sun entering Capricorn. In addition to the sun, the Polaris changes with time. Five thousand years ago the star currently called Thuban was the pole star. {See picture opposite page}. Polaris was established as the pole star around fifteen hundred years ago. According to some ancient writings in the intermediate





period, there was no pole star. Scientists estimate that a brighter star called Vega will become the pole star in about seven thousand years. The reason for all these changes is the wobbling of the earth's axis {See picture above right}.

In addition to the sun and the moon, the planets, which look like very bright stars to the naked eye appear to move with respect to the stars. The sun and moon move from Sagittarius to Capricorn during the course of a year but not from Capricorn to Sagittarius. But unlike the sun and the moon, the planets appear to move backward from time to time. This is called retrograde movement of the planets. Except for stars very close to the Polaris, all stars along with the planets appear to rise in the east after the sun sets and set

in the west before sunrise. Retrograde movement of the planets can only be noticed when the distances between the planets and the stars near to it are measured night after night and duly recorded. Planets will not be seen to move from west to east as the night progresses. As was described earlier, the position of the sun in a given month is slowly changing. This change over thousands of years can not also be called retrograde movement. Actual retrograde movement of Venus {Picture left top} and of Saturn and Mars is visible even without telescopes.

Solar and lunar eclipses, retrograde movement of planets and the change of the Polaris from time to time are very easily visible to the naked eye. So most ancient cultures recorded these events. They tried to predict their occurrence beforehand. Different cultures achieved different levels of success. Some of the ideas used are quite interesting.

Ancient Indians did not use the more familiar 12 constellations of the zodiac but 27 stars. Not all of these are included in the twelve constellations of the zodiac, showing that it was an independent idea. Later on, the Indians began to use zodiac constellations in addition to the 27 stars. And so, the names of the constellations of the zodiac used by other cultures were translated into Sanskrit. Ancient Indians assumed the existence of two extra planets Rahu and Ketu to predict the eclipses. That they named them shadow planets is very interesting. In modern astronomy, Rahu and Ketu are points on the lunar orbit called ascending and descending nodes.